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(This reports covers the MODIS **cirrus characterization and correction** algorithm and part of the MODIS **near-IR water vapor algorithm**)

Main topics addressed in this time period:

1. **MODIS near-IR water vapor algorithm**:

   Science algorithm: The combined V2 near-IR water vapor and aerosol algorithm was delivered to the MODIS Project in mid-November of 1997. Some of the metadata and QA parameters actually were not implemented in that version of the algorithm. Allen Chu is continuing in handling metadata and QA parameters for the near-IR water vapor algorithm. A newer version of the algorithm will be delivered to MODIS SDST in June of 1998.

   Validation plan: Currently, we plan to use water vapor measurements from microwave radiometers, radiosondes, and AERONET to verify water vapor values retrieved from MODIS near-IR water vapor channels. Unfortunately, little concrete steps (for example, how to automatically obtain measurements from different sources) have been taken by Kaufman's research group so far. His group devoted most of the man power and efforts to the MODIS aerosol algorithm. Gao recently examined possibility of automatically getting water vapor measurements from several DOE ARM sites' microwave radiometers. It is likely possible to get the data in digital form soon after the measurements are made.

2. **MODIS thin cirrus and contrail algorithm**:

   Science algorithm: The science algorithm includes two parts: thin cirrus reflectance and contrail detection. The V2 algorithm was delivered to MODIS SDST in early December of 1997. Because the design and interface have been changed at MODIS SDST, quite a bit of modifications to our code have to be made. Wei Han has been interacting with the staffs of MODIS SDST Science Software Transfer Group regarding the algorithm, and making necessary changes.

Since the code delivery in December of 1997, additional progress has also been made in the science algorithm development.

a) Thin cirrus reflectance: The delivered at-launch version of cirrus reflectance algorithm is simple and fully functional. However, the 1.375-µm transmittance factor for water vapor above and within cirrus clouds were estimated based on latitudes and longitudes. The key in our algorithm for retrieving cirrus reflectance in the 0.4 - 1.0 µm spectral region is to accurately estimate the 1.375-µm water vapor transmittance factor. Great efforts have been made in trying to estimate this factor from MODIS' imaging data themselves, instead of based on "guessing". Recently, we seem to find a robust and quick way to make such estimation from imaging data. The transmittance factor is derived from the scatter diagram of 1.375-µm channel vs 1.24-µm channel. The quick sort subroutine in Numerical Recipes is used several times during the derivation. Currently, we are testing this algorithm using spectral imaging data acquired with the NASA JPL AVIRIS instrument during various field campaigns.

b) Contrail detection: The delivered at-launch version of aircraft contrail detection algorithm is functional. The algorithm produces a "contrail mask" image from the 1.38 micron brightness image. In order to limit code memory requirements, each input scene (with size up to 2000x3000 pixels) is split into four equal sub-scenes before processing. The resultant contrail mask is reconstructed from the corresponding sub-scenes. Bill Ridgway has made more efforts in refining the algorithm, to better characterize "ridge" pixels which make up bright linear local features, to modify the straightforward Hough transform in order to prevent the algorithm from trying to connect bright features which are separated by a substantial distance, and to reduce the false contrail identifications significantly.

Validation plan: The development of cirrus reflectance and contrail detection algorithms has always been guided by real imaging data. In the case of developing cirrus reflectance algorithm, AVIRIS data acquired during NASA FIRE Phase II Cirrus experiment in December of 1991 and a few other field programs were used. We have recently obtained additional AVIRIS data from NASA JPL over same areas with and without cirrus cover. These data are being analyzed. In the case of developing the contrail detection algorithm, images acquired with MAS (AVIRIS does not have sufficiently large area coverage), SeaWifs, GOES, and ground-based upward-looking digital camera, have been used.

3. Radiative transfer modeling

We have received simulated ice particle phase functions from Dr. Liou's research group and from Mishchenko. Wei Han recently re-organized a complete set of radiative transfer codes for modeling cirrus cloud reflectances (using Dr. S.-T.

Tsay's DISORT code plus a driver code named STRATS). The codes are quite suitable for our sensitivity studies. So far, we have only made a few modeling studies to make sure that the codes work correctly (by testing against the results published in a book written by Dr. Liou). The codes will be used more often during our future development of MODIS algorithm .

4. **Meeting**

Ridgway, Han, Gao, and Chu participated the Atmospheric Group meeting held in St. Michaels, MD in early February. Ridgway described the contrail algorithm. Gao described the cirrus reflectance algorithm and the module for correcting aerosol effects in the near-IR water vapor algorithm. Chu described his application of the algorithm for water vapor retrievals from MAS data (as reported by Kaufman).

Plans for the next 3 month:

(a): finish updating the ATBD for the near-water vapor algorithm by adding additional sections on correction of aerosol effects.

(b): finish revising the cirrus correction paper submitted to JGR, and use the paper as the basis for writing the ATBD for our cirrus algorithm.

(c): further development of operational algorithms for cirrus reflectance retrievals and for contrail detections.

Publications:

Gao, B.-C., Y. J. Kaufman, and W. Han, Retrieval of column water vapor amount from MODIS channels near 1 μm, submitted to *IGARSS'98*.

Gao, B.-C., Y. J. Kaufman, W. Han, and W. J. Wiscombe, Correction of thin cirrus path radiance in the 0.4 - 1.0 μm spectral region using the sensitive 1.375-μm cirrus detecting channel, Submitted to J. Geophys. Res. in November, 1997, and is currently under revision.

Gao, B.-C., W. Han, S.-C. Tsay, and N. F. Larsen, Cloud detection over arctic region using airborne imaging spectrometer data, Accepted for publication by *J. Appl. Meteorol.*.